Dynamic Drivers of Dams and Transboundary Cooperation: Selected Cases in the Global South

Capstone Paper

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Executive Summary

Hydroelectric dam building in the global south has become a way for countries to shift away from fossil fuels and towards renewable energy sources that utilize the natural resources that they have at hand. Rapid dam construction is not without consequences, though, both for the people and the environment. The Mekong River Basin, with numerous dams and reservoirs, has been an example of the economic and political risks of large dams, as well as issues of food and water security. Other countries in the global south have followed suit, with the promise of international funding for dam construction, the ability to meet clean energy goals, and the potential for an economically secure future being drivers of many major dam projects.

This report aims to summarize and analyze:

- Factors that are driving the rapid construction of hydropower projects, on both a national and international level
- The role of transboundary organizations on water management and dam construction in river basins that contain hydropower projects
- The environmental and social impacts of dam construction

We conclude that some areas that have been rapidly constructing dams are now slowing the pace of hydropower projects as they transition to other alternative energy sources, but other countries have only just begun and still have many projects in the works. Transboundary organizations on the river basins we examined, which focus on International Water Resource Management (IWRM), organize cooperative projects for sustainable development, but tend to have limited power over dam construction. The countries themselves still have the power to determine whether or not they want to continue with hydropower projects. And, finally, countries often emphasize the importance of sustainability and renewable energy, but ultimately

environmental concerns may not be valued over promising economic opportunities.

Introduction

As part of an international trend towards renewable energy, many countries in the global south have turned to the construction of hydropower dams, as a way to meet their energy needs while reducing their impact on the environment. However, this alternative energy source can have negative impacts on the environment as well, particularly in the face of climate change. Additionally, the upfront costs of installing hydropower projects are high, and often countries cannot afford to pay for them on their own, resulting in the need to take out loans from foreign investors. This report analyzes current trends in hydropower in the global south, on the Mekong, Amazon, Nile, and Zambezi river basins. We explore trends from both a national and basin-wide perspective, breaking down the potential influence of outside funding sources and transboundary organizations on dam construction. Through this analysis, we posit that:

1. Some regions are experiencing a slowdown in hydro dam construction, while others are just getting started
2. With increasing global attention to changing climate patterns, dams emerge as a solution to some but part of the problem to others
3. Transboundary management organizations (TBOs) have been primarily supported by international institutions, but there is a push for state and regional ownership and participation

Methodology & Case Selection

This report consists of a summary and analysis of transboundary water management and global trends in dam building on the Amazon, the Mekong, the Zambezi, and the Nile rivers. The research was done through a literature review, which included sources such as academic journal articles, books, the websites of transboundary organizations and non-profit organizations,

government documents, and recent news articles and videos. The Mekong River was used as a comparison case for this research, as the Stimson Center has done extensive research on dam building in this area. The Mekong is a prime example of rapid development in hydro-dam projects, which can be economically and politically risky, as well as lead to issues involving food and water security.

The following rivers, and countries of focus within these river basins, were selected for comparative research:

- The Nile River (Egypt and Ethiopia)
- The Zambezi River (Zimbabwe, Zambia, and Mozambique)
- The Amazon River (Ecuador and Brazil)

A combination of the presence of transboundary water management organizations as well as the recent and ongoing construction of large dams in these areas formed the basis on which these cases were selected. Additionally, cases in the global south were selected for comparison with the Mekong, to better evaluate economic factors, international water resource management, and the influence of outside actors. Finally, we aimed to cover a variety of drivers and effects of dam construction through the selection of these cases, which ranged from potential impacts on tourism in the face of climate change (in the Zambezi and Ecuador) to shifts to renewable energy sources other than hydropower (Brazil and Egypt).

Background on Large Dams

In many developing economies, large and major dam projects are perceived as vital infrastructure and energy investments that reap benefits by providing needed energy, manage distribution of water resources, and can operate over a long period of time. Large dams are defined by the International Commission on Large Dams as a dam larger than 15 meters tall,

with major dams categorized as over 150 meters tall, with over 25km3 of reservoir storage, or producing over 1,000 megawatts of power (ICOLD, 2018). There are currently nearly 60,000 large dams. Around the world, dams are used for a variety of purposes, the most common being irrigation, water supply, flood control, and hydroelectric power generation. Hydroelectric dams are used to achieve economic growth through energy production and further infrastructure expansion promoting regional connectivity, while also addressing global movement towards other renewable energy options. Today, hydroelectric dams provide around one-fifth of the world's electricity. While dams producing hydroelectric power emerged in North America at the beginning of the 20th century and jump-started countries like the United States and Canada as hydroelectricity producers, new growth of hydropower in North America, Europe, and Japan has slowed substantially, as most potential has already been exploited. Currently, the largest producers of hydroelectric power are China (331,110 MW), the United States (102,485 MW), and Brazil (98,015 MW) (IHA, 2016). Other emerging economies like India, Turkey, and Russia also produce large amounts of hydroelectric power.

Dam-affected communities and environmental advocates lobbied international institutions such as the World Bank to review the impacts of dams and to set international standards that address and mitigate negative social and environmental effects from dam construction. The World Commission on Dams was the first comprehensive global review of the dams and their contribution to development. The investigation was conducted independently by a group of commissioners representing a variety of stakeholders, including dam critics and proponents. The report, published in 2000, highlighted the impacts of large dams and strategies to manage human rights, the right to development, and assessing the risks of projects (WCD, 2000). For an international standard on decision making, the report suggested of reaching

negotiated outcomes transparently with all stakeholders. This recommendation attempted to alter and go beyond the norm of 'informed consent' or consultation with affected communities. Furthermore, the conclusions of the report recommended that "large dams be built under a set of internationally agreed norms that were aligned with international laws and principles...dams should be financed only after raising the quality of dam design to the level of best practices." (Goodland, 2010). The findings of the report confirmed assertions by dam critics that risks and impacts of large dam projects had been underemphasized in development planning, and urged more participatory decision making in order to truly assess environmental and social tradeoffs.

One major critique from a variety of dam proponents in developing countries is that the international norms proposed by the World Commission on Dams come from the Global North and would impede the development of the Global South with restrictive regulations. After the report was released, governments such as India, Turkey, and China disputed the findings, citing them as prejudiced, aggressive, and in the pocket of nuclear and thermal energy investors to undermine hydropower as a source of energy (McCully, 2001). The friction between the the right to development and environmental and social rights for low-income countries underlines the tension between contemporary infrastructure development in the Global South and past development in the Global North, which was at one point almost unhindered by environmental, financial, and social regulations.

Impacts

The impacts of dams on the environment and the surrounding communities have been highlighted by environmental and human rights activists as well as dam-affected communities as reasons to halt, delay, or modify dam construction. According to dam opponents, large dam projects do not serve the economic growth goals of states because of increased political and

financial risk, as well as negative social and environmental impacts that outweigh the benefits of the projects.

On the one hand, hydroelectric dams provide around one-fifth of the world's electricity. In South and Central America, nearly 60% of electricity generated comes from hydropower (McCully, 2001). Dams also provide water to support food production. The World Commission on Dams estimated that dams contribute 12-16% of world food production with their water resources (WCD, 2000).

However, large dam projects also have impacts on the ecosystem. Changes in river flow from upstream to downstream has effects on riverbanks, deltas, and coastline due to the trapping of sediments in dams. With dams reducing natural flooding, agriculture in areas that receive rich sediment deposits in the floodplain can severely reduce agricultural production. In addition, many fish are no longer are able to spawn up rivers, and some species are affected by morphological changes to their habitats and changes in water temperature due to altered water flows. With the decline in fish species, the livelihoods of river communities are also substantially impacted. In the Mekong Delta, three-quarters of the 70 million people in the basin rely on fisheries or farming as a source of income and food (UNEP, 2006).

Large projects also can have social and economic impacts throughout the basin, especially among river communities. The WCD estimated that 40-80 million people have been displaced by dam construction (WCD, 2000). Displacement is often forced, and affected communities are usually undercompensated for their land and livelihoods.

Although hydroelectricity is purported to be clean, renewable, and cheap, research has shown that there are substantial methane and carbon dioxide emissions from rotting vegetation in dam reservoirs, contributing to climate change (Deemer et al, 2016). When compared to non

renewables like oil, gas, and coal, hydropower has an environmental advantage, but still contributes to greenhouse gas emissions.

Trends

New drivers of development and changing political landscapes have shifted how dam development is perceived in the almost twenty years following the report. Water and energy demand has increased, with energy demand expected to almost double from 5.2 to 9.3 terawatts between 2010 and 2035 (IEA, 2011). Climate change has also changed hydropower expansion--some actors promote hydropower as a carbon neutral energy strategy, while others note that dams on river basins experiencing drought conditions result in volatile and diminished power production due to reduced water flow. Political factors like the emergence of environmental and social justice movements in countries at least somewhat responsive to civil society draw political attention via protests, lawsuits, and advocacy to improve public consultation efforts for projects. Regional power struggles over scarce water resources also drive the desire to grow as quickly as possible. In the past, hydropower was considered to have low operating costs once constructed and a long life, especially when compared with non-renewable sources of energy. However, volatile energy output from dams, cost overruns, and a large burden of public debt have made large dam projects seem more financially risky to investors, particularly without substantial government subsidies. In an evaluation of a selection of large dam projects, 3 out of 4 dams had a cost overrun, which averaged 96% higher than the estimated cost, with a median overrun of 27% over cost. In addition, 8 out of 10 dams had a schedule overrun, taking on average around two years longer than expected to finish construction (Ansar et al, 2014). Despite these increased financial risks, in some cases dams are perceived as a viable and valuable form of infrastructure development.

Projections from the International Energy Agency for 2017-2022 forecast of a slowing down of hydropower capacity growth worldwide, primarily due to slowdowns in Brazil and China. Around one-fifth of the growth is attributed to pumped storage plants, which store water in reservoirs at times of low electricity demand and release water for energy production at times of high demand (IEA, 2017). In areas with regionally connected grids, power can be exported, contributing to domestic revenues and enticing foreign investment.

While international and regional development banks like the World Bank used to fund large dam projects in the 1960s and 1970s, they have since moved away from new projects in favor of dam refurbishment, grid efficiency improvements, or alternative renewables like wind and solar. However, the capacity for wind and solar expansion at a larger scale may only be available to emerging middle income economies with some of the grid infrastructure, government supports, and capital access to invest in the emerging technologies: "While some non-OECD countries are developing a portfolio of renewable energy capacity (e.g. Brazil, China and India), medium-term deployment in most countries still hinges on cheap and abundant hydropower resources" (Bahar, 2017). Although the global price of wind and solar has decreased substantially over the past few years, wind and solar face similar excess supply and storage issues as hydropower, and must also have institutional and financial supports in order to be integrated into the state's energy portfolio at a larger scale.

Other investors have emerged to fund hydropower projects to more equitably share risks. As public utilities have begun to deregulate and privatize, public-private partnership models were developed to increase private financing. China is also prominent as a funding partner of new projects in Africa, Asia, and Latin America, following its infrastructure development strategy, One Belt, One Road, which will invest almost a trillion dollars a year on infrastructure

investments around the world in the next decade (Dollar, 2015).

Regional conflicts between riparian states are not a new phenomenon, but become increasingly important as water resources become more scarce and countries desire economic growth. These conflicts highlight the importance of international and regional cooperation at a basin-wide level in order to sustainably manage water resources. The World Commission on Dams report placed the spotlight on the impacts of large dams and made suggestions for policy change to increase cooperation. However, in some cases the power dynamics between riparians and the desire for economic growth may not have dampened the inclination towards hydropower and dams. In other cases, factors such as climate change and increased political and financial risks have made dams less desirable as a strategy for development. The table below summarizes descriptive characteristics of our selected cases.

Summary Matrix for Selected River Basins

Factor	Mekong	Amazon	Nile	Zambezi
Length of River	4,909 km	6,992 km	6,853 km	2,574 km
Number of Riparians	6	8	11	6
Name of Major Dams	Xayaburi, Don Sahong, Pak Beng	Coca Codo Sinclair, Belo Monte	Renaissance, Tekkeze	Kariba, Cohora Bassa, Batoka Gorge
Hydroelectric Installed Capacity	25,000 MW	78,000 MW (Brazil)	1,964 MW (Ethiopia)	5,000 MW
Hydroelectric Potential	29,000 MW Upper 30,000 MW Lower	≈60,000 MW	15,409 MW (Ethiopia)	20,000 MW

Hydroelectric Capacity and Potential: A path to development

Compared to countries in the Global North, countries in the Global South have exploited much less of their hydropower resources. The untapped potential of the river basins is seen as an economic resource that can foster foreign and domestic investment, spurring growth and meeting energy demand. In our selected cases, we outline how the main riparians have built out their installed hydropower capacity and their energy projections for the near future. In some cases, energy demand is easily met by the dams that already exist, but in others, high and increasing demand must be met by expanding other sources of energy.

The Mekong River Basin

The Mekong River, the eighth longest in the world at 4,909 kilometers, flows through China, Burma, Thailand, Cambodia, Vietnam and Lao PDR. The basin is divided into two parts, the Upper Mekong (Lancang) Basin in mountainous China and the Lower Mekong Basin flowing through floodplains and lowlands. The estimated hydroelectric potential of the Lower Basin is 30,000 MW, and the potential for the Upper basin is 29,000 MW (MRC, 2018). There are currently over 100 dams planned or installed on the Mekong River and its tributaries.

The six riparian states of the basin all have ambitious development goals that aim to promote economic growth. Laos strives to reduce poverty and leave behind its 'Least Developed Country' status. To do so, it wants to export its surplus hydroelectric power to its neighbors and become the 'battery of Southeast Asia.' However, the country has few economic resources and must rely on outside investors to fund dam projects, often in a build-own-operate-transfer model. Current dams under construction in Laos include the Pak Beng and Xayaburi dams in the north, and the Don Sahong dam in the south (International Rivers, 2018). Of 11 proposed mainstream dams in the Mekong region, 9 are in Laos.

Cambodia has struggled to meet basic electricity needs in electrifying rural areas and connecting power grids throughout the country. Only about a tenth of its hydropower potential has been exploited, but the country still has to import some electricity from its neighbors. The Lower Sesan II dam, in construction on a Cambodia tributary of the Mekong partially completed, is projected to deplete fish stocks in the basin by 9.3%, which would devastate the fishery-reliant economy (International Rivers, 2018).

Vietnam and Thailand, on the other hand, have higher incomes and more sophisticated power generation and distribution systems. They seek to import hydroelectricity as well as expanding coal and the use of renewables like solar and wind. In addition to high relative power consumption in the region, Vietnam and Thailand have high projected energy demand growth, with demand in Vietnam growing 10-12% annually (Eyler & Weatherby, 2017).

Although China is the world's largest producer and consumer of electricity and hydropower, energy demand is slated to decrease in the coming decades. In addition, China has increased their domestic capacity in hydropower, wind, and solar, reducing its reliance on imports from its neighbors. The six cascade dams upstream in China's Yunnan province have provided hydropower domestically, as well as influencing water flows downstream.

Brazil

Other than China, Brazil is the largest producer of hydropower in the world, with over two-thirds of its electricity generation coming from hydroelectric power. Dams have historically been important in Brazil, particularly the Itaipu Dam on the Paraná River near the Paraguay-Brazil border. In 2015 and 2016, the Itaipu Dam surpassed the largest dam in the world, the Three Gorges Dam in China, in energy production for the first time, producing 103.1 terawatt/hours of power in one year (Ingram, 2016). Most of the unexploited hydropower

potential is in the Amazon region of Brazil, containing the Amazon River and its tributaries as well as many protected rainforests. Projects in the Amazon primarily operate as run-of-the-river projects, meant to avoid the large flood areas of reservoir projects. However, in combination with the rainy and dry seasons, run-of-the-river projects mean there is high seasonal variability in water flow and power production for dammed rivers.

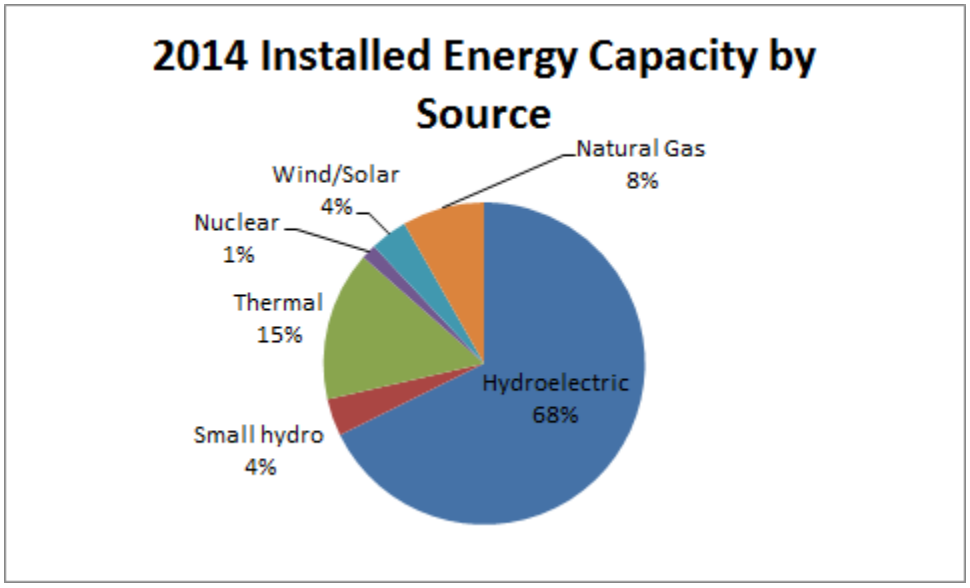
The Brazilian Belo Monte dam on the Xingu River, a tributary of the Amazon, is slated to be the world's fourth largest dam, with a capacity of over 11,000 MW once completed in 2019. First proposed in 1975 under the military dictatorship's strategy of economic growth and national security, the plans for the dam have since been modified, ostensibly to incorporate environmental concerns and consultation with affected groups. Although 10 out 24 turbines are operational, its installation and operating licenses have been suspended by federal courts several times due to environmental and social concerns in compensating local communities. Other large projects have been suspended as well: the license for the planned São Luiz dam in the Tapajos River was canceled by IBAMA, Brazil's environmental agency, in August 2016. There are currently over 250 dams planned, under construction, or in operation in Brazil (Dams in Amazonia, 2018).

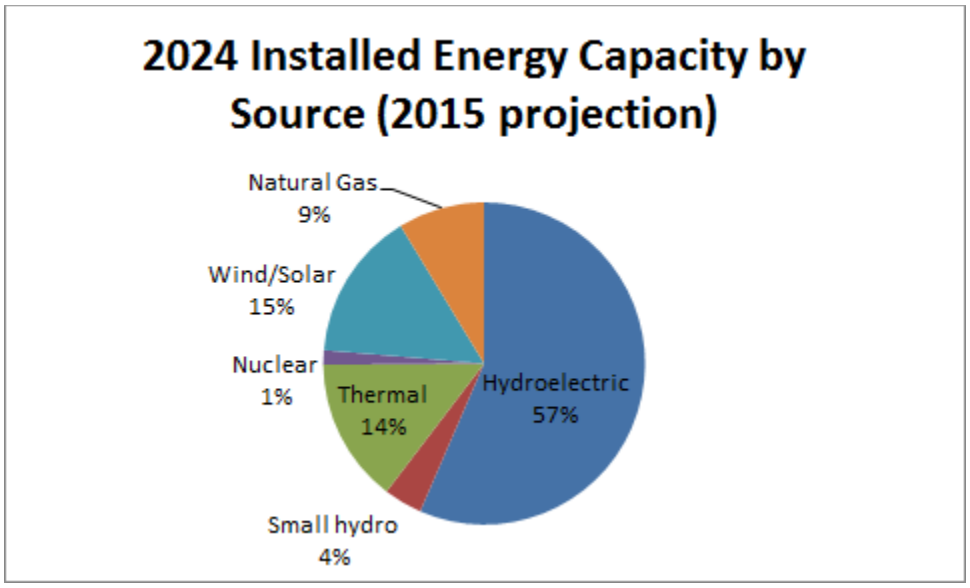
Brazil expects to expand its hydropower production in the next ten years, although economic conditions have reduced energy demand. Projections from the Brazil 2024 Ten Year Energy Expansion Plan (Plano Decenal de Expansão de Energia, PDE) project hydropower expansion to increase from 87 to 112 gigawatts (GW) by 2024 (PDE, 2015). However, the 2026 PDE outlines a more conservative projection of 103 GW from hydroelectricity by 2026 (PDE, 2016). This is due to a change in projections in the power mix of the country to include more solar and wind power, as well as acknowledging slower economic growth rates and difficulties in

obtaining and sustaining environmental licensing for new projects. Brazil faced an economic crisis in early 2015 that changed its projections for economic growth between the 2024 Ten Year Plan and the 2026 PDE. With eight quarters of negative growth, high unemployment, credit restrictions, and lack of investor confidence weakened domestic demand, retracting major sectors of the economy that use hydropower such as agriculture, industry, and services (Trading Economics, 2018).

The 2026 PDE projects a 1.4% annual average growth rate for the first half of the decade, accelerating to 2.3% in the second half of the decade, presenting energy efficiency along with reduction in consumption across commercial, residential, and industrial sectors as accounting for the reduction throughout the decade (PDE, 2016). The PDE points out that demand for electricity will increase over time as less connected regions become electrified and commercial and residential development continues, even with stagnation in the economy. The table below shows the energy capacity projections for Brazil between 2014 and 2024.

Brazil Energy Projections and Installed Capacity by Source, 2014-2024





Source: 2024 Plano Decenal de Expansão de Energia (PDE)

The inflexibility of hydropower dams in terms of siting is compounded by the inflexibility of adjusting to changing energy demand over a long project period, and demand forecasts consistently overestimate future needs (McCully, 2001). Although the Brazilian government has adjusted its projections for energy demand, it still may be overestimating the need for electricity, especially with a decreasing population growth rate currently comparable to the United States of around 0.8% annually (World Bank, 2016). Looking for smaller scale, more flexible sources of energy and energy storage may reduce the economic risk faced by the Brazilian government in these large projects.

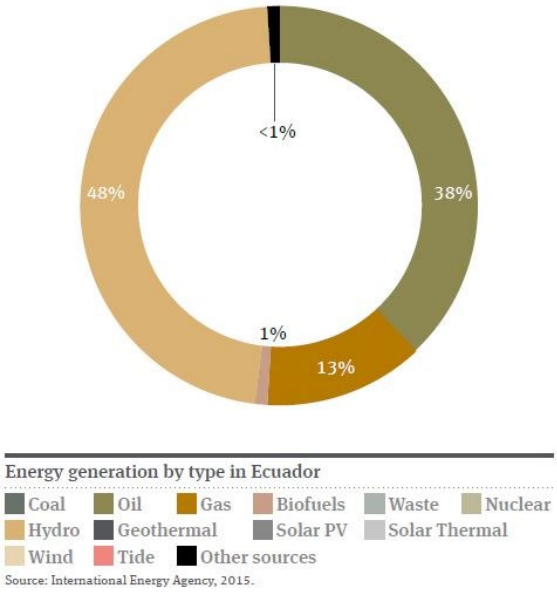
Ecuador

Over the last few years, Ecuador has become a prime example of development in the hydroelectricity sector. With the highest concentration of rivers per square kilometer of any country in the world, it may seem natural that hydroelectric dams would become part of the developing landscape. However, the factors driving the construction of these dams are complex and include political relations, sustainability considerations, and long-term financial risks and

benefits of dam construction.

In 2008, a new constitution was introduced by President Rafael Correa, placing emphasis on sustainability and indigenous rights (Gatehouse, 2017). Focusing on clean energy seemed like the perfect solution to boost the economy and create jobs, while also committing to more sustainable practices. A "Master Plan of Electrification" was created by the government in 2012, which would involve the building of 8 hydroelectric dams over the course of 9 years (Gatehouse, 2017).

Alternative Energy Potential in Ecuador



Source: Norton Rose Fulbright, 2016

Hydropower remains the most viable source of renewable energy potential in Ecuador. Hydropower is the second largest energy source in the country, following oil, which in 2016 accounted for 76% of the country's energy consumption, while hydro accounted for 19% (Hellenic Shipping News, 2018). Thus, the government has placed most of the focus on hydropower projects, with a goal to have 90% of energy coming from hydro sources by 2017 (St. James, 2016). There is the potential for solar, wind, and other renewable energy sources,

however developing a grid in the mountainous landscape is difficult, so it has not been a focus.

Ethiopia

Ethiopia is located in the Eastern part of Africa and is considered one of the largest riparian countries of the river Nile occupying second place after Sudan. The population of the country was estimated to be 102 million with growth rate of 2.6 percent annually (Word Bank, 2016). The topography of Ethiopia is very mountainous, posing extreme challenges to the development of the country's infrastructure. Due to many political, social and economic vulnerabilities as well as climate change, Ethiopia is rendered in the least developed countries in the world (Swain, 2011). The Ethiopian economy depends mainly on rain fed agriculture with very limited infrastructure for industrial/ mass agriculture (Martens, 2011). Nevertheless, in the recent years, political stability has been increasing as the new Ethiopian government tries to catch up with the fast-developing world and meet its population's needs. This new form of stable governance sets developing the nation's infrastructure, economy, and agriculture among the first priorities with developing water resources at the heart of the economic development scheme. Thus, Ethiopia has begun to receive increased international attention and donor funding (Martens, 2011).

Ethiopia has only been able to exploit 5 percent of its total surface water that comes from the Nile (Arsano and Tamrat, 2004). Around 4.7 percent of the utilized water is used in agriculture for irrigation (Arsano, 2007). Yet, this situation is shifting as the government plans to amplify the irrigation capacity using hydropower. The Nile as the major water source will hence play a substantial role. According to Ethiopian officials, there is a pressing need to dam the river Nile flow in Ethiopia and utilize the generated hydropower for large-scale irrigation (Arsano, 2007). The Ethiopian Electric Power Corporation (EEPCO) emphasizes on the intention to

significantly expand the hydropower capacity of the country over the next few decades mainly through the construction and completion of the Grand Renaissance dam. The construction of five hydropower dam projects has been initiated with the help of international funding, particularly from China (Martens, 2011).

Egypt

The western Saharan Desert constitutes the largest portion of the Egyptian territory. The people of Egypt settle along the narrow strip of land along the banks of the river Nile and the Delta. People live in about less than 6% of Egypt's land area (OECD, 2004). The Nile in Egypt is the only source of water for drinking and irrigation. Recently, however, the country has been facing severe water scarcity and the situation is expected to exacerbate in the future.

It is important to differentiate between two forms of water scarcity. Most of the African countries face economic water scarcity due to the underdeveloped infrastructure and the under-use of their water resources. Egypt, on the other hand, is confronting physical water scarcity. The country has adequate resources to regulate the water of the river Nile but has minimal potential for any further utilization. According to the 2016 Water Stress Index Report, Egypt is categorized as a country facing chronic water scarcity. Due to Sudan not fully exploiting its share of water from the Nile in the past, Egypt had been withdrawing more than its legal share of water in order to meet its population demands. Relying on the overuse of the Nile water, the country has lately developed new irrigation projects, such as the Southern Valley Development Project which required the utilization of approximately 10 percent of Egypt's share of water. Yet, with the changing hydro-politics and the need for economic development in both Ethiopia and Sudan, these projects are in question and there is a pressing need for alternative sources of energy.

In order to face this chronic water shortage and due to the incapacity of hydropower

projects in Egypt, the government opted to resort to alternative sources of power to meet the population demands. Recently, Egypt inaugurated the first solar power plant to generate as much as 2 GW from the sun, curbing the country's reliance on unsustainable sources of energy (Elwardany, 2018). Egypt is also looking at nuclear and wind power to generate electricity and light up its new cities.

The Zambezi River Basin

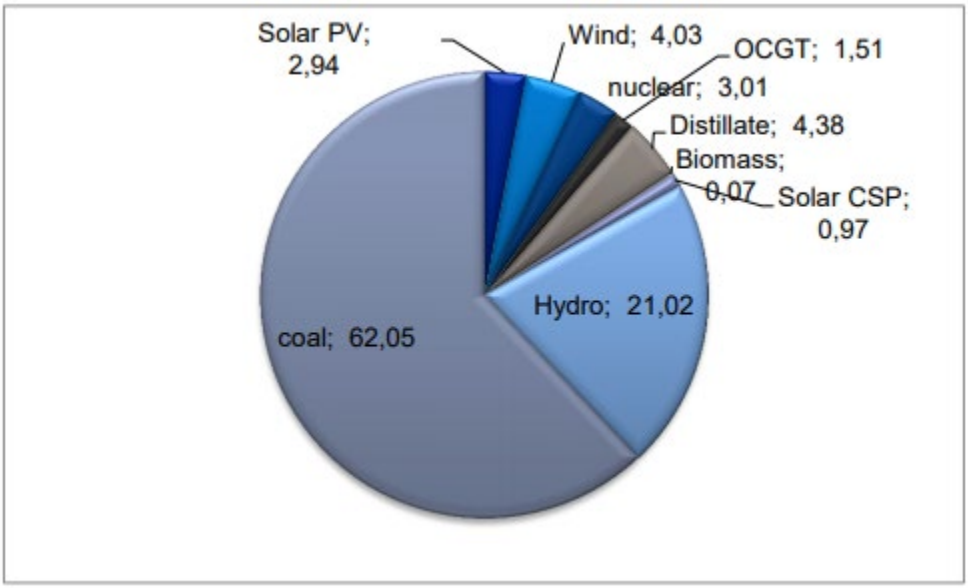
From its source in Northern Zambia, the nearly 1,600 mile-long Zambezi River flows through 6 countries (Angola, Namibia, Botswana, Zambia, Zimbabwe, and Mozambique) before emptying into the Indian Ocean. It is the fourth largest river in Africa and has a catchment basin area that is slightly less than half of the Nile's. The Zambezi River basin also has one of the most variable climates in the world, which makes the basin system particularly susceptible to climate change effects.

There are two large dams found along the river (the Kariba Dam and the Cohora Bassa Dam), as well as plans for building a third. The Kariba Dam, built in the 1950s, is on the border of Zambia and Zimbabwe, and the Cohora Bassa Dam (built in the 1970s) is in Mozambique. They primarily provide power for Zambia, Zimbabwe, and South Africa. There is also a proposed 3rd dam, the Batoka Dam, to be built along the Zambia/Zimbabwe border. This dam has been proposed several times over the last three decades and has been met with much resistance. A few of the major reasons for this are the prominent Victoria Falls, just a short distance upstream from the proposed site as well as the effects the dam would have on whitewater rafting sites in Zambia. The tourism around these two sites are a source of livelihood for thousands of locals (Sanyanga, 2014).

Hydroelectric dams along the Zambezi River are one of the major contributors to the

Southern African Power Pool (SAPP). However, the power production capability of dams on the Zambezi River is being threatened by a variety of factors. The main source of water for the Zambezi River is rainfall. This is troublesome for two main reasons. First, the Zambezi is located along the Inter Tropical Convergence Zone (ITCZ), which causes drastic dry and wet seasons. Secondly, climate change has further complicated consistent sources of water by changing rainfall patterns and making them more erratic. This has made cooperative water management along the Zambezi River Basin a necessity to meet the energy demands of its riparian countries and for the wider Southern African Development Community (SADC) and the Southern African Power Pool (SAPP).

SAPP Installed Generation Capacity by Technology-2015



Source: SAPP, 2016

Along the Zambezi River the three countries farthest downstream are home to the two currently operating large dams, and the 3rd proposed large dam. These countries are Zambia, Zimbabwe, and Mozambique, and are the largest producers of electricity of the Zambezi riparian nations.

Southern African Region Electricity Demand

Country	Main Utility	Installed Capacity (MW)	Estimated Annual Demand (MW)	% Growth in Demand
Angola	ENE	1,128	593	11%
Botswana	BPC	132	510	6%
DRC	SNEL	2,442	1,335	3%
Lesotho	LEC	72	114	3%
Malawi	ESCOM	302	303	4%
Mozambique	EDM	2,330	462	7%
Namibia	Nampower	393	476	5%
South Africa	ESKOM	43,061	37,365	3%
Swaziland	SEB	51	251	5%
Tanzania	TANESCO	1,186	793	8%
Zambia	ZESCO	1,985	1,700	6%
Zimbabwe	ZESA	2,045	2,421	2%
TOTAL		**55,032**	**46,062**	**Ave. rate 5%**

Sources: SADC Today; Volume 11, (2008), Ministry of Energy and Water Development (2010) ZESCO (2013)

Zambia

Hydroelectric power is second largest energy source in Zambia, after wood fuel. Zambia borders 41% of the Zambezi River and is estimated to have 40% of the water resources in the SADC. Zambia has about 6,000 MW unexploited hydropower potential, with only around 2,200 MW developed. There have been no major additions to Zambia's generation capacity in almost three decades (Zambia Development Agency, 2014). However, that will change when the Bakota Gorge Dam is completed. This increased production capacity is much needed due to the positive economic growth Zambia has been experiencing in the recent past, which has already surpassed the 2014 installed capacity shown in figure above.

Other than the untapped power capability of the Zambezi River, Zambia also has enough sunshine per year (2,000-3,000 hours of sunshine per year) to make solar power plants a viable and productive option. However, the initial cost of solar power plants is still too high for Zambia. As of yet, solar power has only been made possible in small projects through donor funding. If

the initial cost of solar power were to drop it could become a very productive alternative energy source, and would alleviate the pressure on the Zambezi River.

2014 Installed Production Capacity (in MWs)

No	Power Station	Installed Capacity	Type of Generation	Operator
1	Kafue Gorge	990	Hydro	ZESCO
2	Kariba North Bank	1,080	Hydro	
3	Victoria Falls	108	Hydro	
4	Lusemfwa and Mulungushi	56	Hydro	Lusemfwa Hydro Corp.
5	Small Hydros - combined	25	Hydro	ZESCO
6	Isolated Generation	8	Diesel	
7	Gas Turbine (stand by)	80	Diesel	Copperbelt Energy Corp.
	Total Installed Capacity	**2,177**		

Source: Wishart, 2015

Zimbabwe

Zimbabwe is currently facing an energy crisis brought on by aging power plants and deteriorating energy infrastructure. Figure 3 shows an installed energy capacity of almost 2000 MW, and an actual energy output of less than half of the installed capacity. One major factor contributing to this energy crisis is the deterioration of the almost 70 year old Kariba Dam and a major drought that reduced the water levels in its reservoir. Zimbabwe and Zambia, through the Zambezi River Authority have plans for a rehabilitation project for the Kariba Dam. Additionally, Zimbabwe has already started a $171 million Kariba South Extension project to boost the productive capacity of the dam.

Zimbabwe has been able to import power from Mozambique, the Democratic Republic of Congo, South Africa, and Zambia to make up for this downturn in actual power generation. However, Zimbabwe hopes to be able to meet its energy needs with the Batoka Gorge large dam project.

Zimbabwe 2016 Power Generation (in MWs)

Power Station	Installed Capacity	Actual	% of Installed Capacity
Kariba South Hydro	750	,440	58,67
Hwange Thermal	920	268	29,13
Harare Thermal	80	30	37,50
Munyati Thermal	80	30	37,50
Bulawayo Thermal	90	15	16,67
Total	**1920**	**783**	**40,78**

Source: ZEDTC

The national electrification rate is approximately 40 percent, with rural electrification being a little lower than 20 percent.

Zimbabwe also has a few other untapped sources of renewable energy. There is still much untapped hydroelectric potential along the Zambezi River, estimated at around 30 TWh per year. The nation has also started construction of two solar power plants that are estimated to have production capacity of 100 MW each (Business Sweden, 2016).

Mozambique

Mozambique is estimated to have a hydropower generation potential of 15,000 MW per year. Of that only 2,100W is currently installed. This leaves a large untapped potential that Mozambique can use to meet its current energy needs. However, power transmission has become a huge problem for the country. This is primarily due to the fact that Mozambique is a relatively large country with very dispersed settlement patterns. This makes the costs of installing power transference infrastructure prohibitive (Hivos, 2009).

Most of the installed hydropower capacity in Mozambique comes from the Cohora Bassa Dam, which has an estimated generation potential of 2,000 MW. However, recently the water levels in the reservoir have been low, which has reduced the power generation capacity (Poindexter, 2016). Not only is this creating an energy crisis for the nation, but also affects the ability of the nation to earn financial capital as a regional energy exporter (primarily to South

Africa).

Mozambique also has great potential for solar energy production. The country is estimated to have 1.49 GWh of solar energy generation potential, which is largely untapped (Hivos, 2009).

Investment in Hydroelectric Dams

The financing of new dam projects has shifted from mostly public, state-led projects to increasingly complex public-private partnerships between international firms, export-import banks, and regional development institutions. International and regional development banks such as the World Bank no longer fund new infrastructure projects such as hydropower dams in all regions of the Global South, although its funds are still present in regions like southern Africa. Private sector and bilateral investment in dams has grown, particularly from countries like China, who are seeking to invest in infrastructure around the world. At the same time, the financial risks present in such considerable investments make some investors question the economic viability of large dam projects compared to other renewables.

The Mekong River Basin

In addition to investing infrastructure in other parts of the world, China has also invested in projects on the Mekong downstream via state-owned firms, such as Sinohydro and China Southern Power Grid Company Ltd, as investor or developer in around 21 hydropower projects in Laos and Cambodia (Han, 2017; Merme et al, 2013). Thai banks also have large investments in hydropower projects. Six commercial Thai banks are funding the Xayaburi Dam in Laos. The dam is being built by a Thai construction company and the Electricity Generating Authority of Thailand (EGAT) is contracted to purchase 95% of the dam's electricity (International Rivers, 2018). Although a smaller regional power than China, Thailand is also able to exert regional

economic influence on investment-hungry neighbors like Cambodia and Laos.

Brazil

Since the mid-2000s, most financing for hydroelectric dams in Brazil has come from the national development bank, Brazilian National Bank for Economic and Social Development (BNDES). The bank finances large projects such as the Belo Monte Dam for around 80% of the project costs, or approximately $11 billion USD (Bank Track, 2016). The remainder is financed by the Norte Energia consortium, which is primarily made up of national partners including state power company Electrobras, state pension funds, and private Brazilian construction firms. However, as of February 2017, the majority stakeholders in the consortium have expressed interest in selling their shares. Chinese utilities companies State Grid Corporation and China Three Gorges corporation have emerged as possible buyers of the shares (Reuters, 2018). The recent economic recession in 2015 has increased macroeconomic instability, especially putting pressure on state-managed pension funds (combined with increasing costs of the project). Skeptics of the financial viability of large dam projects say that in cases like Belo Monte, a lack of private investment signals that there is a high risk on returns that only the government is able to absorb (Bank Track, 2016). Other Brazilian dams have more diverse mixes of private and public investors, but the size of a project like Belo Monte represents a not only a large proportion of energy production for the country, but also high proportion of its debt balance sheet, which would only increase with scheduling delays and increased costs to address federal court rulings.

Other aspects of power production in Brazil are financed by foreign private investment. In particular, Chinese companies are emerging as investors and owners of power transmission lines and smaller dam projects. In September 2017, the State Grid Corporation, owned by China, purchased the remaining shares of Brazilian CPFL Energia and now owns 100% of the company.

CPFL has a 13% market share of power distribution in Brazil (China Daily, 2017). The State Grid Corporation operates around 7,000 kilometers of lines in Brazil, with over 6,000 additional kilometers under construction. Chinese investment in Brazil reached a recent high of nearly $25 billion in 2017, primarily in energy, oil , and gas, though the construction and services industries are emerging as new markets (Biller, 2018). Chinese firms also seize other opportunities, making acquisitions from American firms exiting Brazil. In 2016, China Three Gorges Corporation acquired ownership of 10 hydropower facilities from a North Carolina firm, a total of around 2,000 MW of power (Duke Energy, 2016). Chinese investment in Brazil is part of its One Belt, One Road infrastructure investment plan of one trillion dollars globally, making China a major player in foreign direct investment alongside other power like the United States, Japan, and the European Union. In general, Chinese investment in Brazil is perceived as an opportunity for renewed growth of the stagnant economy, but concerns about dependence on foreign investors and their encroachment into some sectors formerly dominated by the government make some wary.

Although historically international and regional development banks have helped finance large dam projects in Brazil, direct financing for hydroelectric infrastructure projects slowed substantially after 1980. The World Bank committed over $750 million USD to hydroelectric energy projects, mostly in the 1960s and 1970s (World Bank Project Database, 2018). Currently, it does not fund any dam projects in Brazil. However, in 2009 the Bank made a $1.3 billion dollar loan for Sustainable Environmental Management Development Policy improvements. The main goals of the loan were to strengthen the government of Brazil's environmental management system by integrating environmental concerns into social and economic policies to achieve sustainable development goals. The objectives included improving the management of

agricultural, forest, and water resources, and promoting renewable energy by establishing climate change planning as a national priority (World Bank, 2009). Though the results were disputed by the Brazilian government, the World Bank project performance report concluded that there was "little if any discernible improvement in BNDES's environmental and social system" and cited the Belo Monte dam as an "emblematic example of the continuing weaknesses in BNDES's environmental and social management system" (IEG, 2015). Overall, the Bank criticized BNDES for its lack of guidelines for hydropower planning and not meaningfully integrating environmental and social principles into its financial investments. Some critics consider the World Bank's Development Policy Loans a "softer and gentler form of conditionality" from the Structural Adjustment Loans rampant in Latin America in the 1980s (McElhinny, 2009).

The regional Latin American/Caribbean Inter-American Development Bank (IADB) does not fund any new energy projects in Brazil, but recently funded the rehabilitation of the Furnas Luiz Hydroelectric project near Sao Paulo for $150 million USD (IADB, 2018). In its energy sector lending, the IADB finances wind, solar, and biofuel projects, as well as retrofitting hydroelectric facilities for efficiency and environmental and social standards. It seems apparent that the IADB prioritizes efficiency improvements, diversity of energy sources, and capacity building of energy institutions. Despite its historical contributions to dam infrastructure projects, the IADB is distancing itself from new hydropower projects, at least in Brazil.

Despite its strong financial commitment to large projects like the Belo Monte Dam, BNDES is looking to diversify from hydroelectric energy sources:

> The Brazilian energy grid, although renewable, has more than 60% of its generation from hydroelectric sources, which tends to be increasingly exposed to the effects of climate change and drought periods. Given this context, the new partnership seeks to promote alternative energy, supporting the diversification of the grid and increasing the security of the system in the future, in order to ensure the supply for all the economic sectors (BNDES, 2018).

As recently as January 2018, the Ministry of Mines and Energy announced the Brazilian government's intention to shift away from mega dam construction, stating that the costs associated with the projects were "much less competitive than previous assessments" (Watts, 2018).

The shift away from international and regional development bank funding for dam projects in Brazil, as well as economic pressures on state financed projects, means that Brazil has two main options--secure private finance or diversify its energy portfolio to include alternative renewables like wind and solar. From its financial ties to China and its public commitment to increasing wind and solar projects, there is evidence that it is doing both, even as it pushes forward the completion of the final stages of the Belo Monte dam by 2019.

Ecuador

In order to finance expensive hydro-dam construction projects, the government of Ecuador has relied heavily on loans from China. Although financial transparency is an issue, estimates for the country's debt to China are estimated to be at least $15 billion (Pskowski, 2016). For the Coca Codo Sinclair dam, Ecuador requested over $1.5 billion from China in order to finance 85% of the project, the largest amount loaned by China to any country in the region (Ortiz, 2010). Although the dam is estimated to supply 35% of the energy needs for the country, the potential environmental impact and the amount of interest owed to China have been widely criticized (Ortiz, 2010). The Ecuadorian government has not seen the expense associated with the construction of dams as an issue in comparison with the perceived benefits of hydroelectricity. Thus, the opportunity to receive funding from China for a shift to renewable energy that is in line with the commitments made in their constitution has driven the continued construction of hydroelectric dams.

The Nile River Basin: Ethiopia

China is considered a key foreign actor that influences land use and water management in the Nile Basin. The Chinese interest in Africa is derived from obtaining energy sources and raw materials for its rapidly growing industries and economic development. The rapidly increasing growth in foreign trade between China and Africa since the 1990s has stunned the Western hemisphere of the globe (Schüller and Asche, 2008). The reasons behind the Chinese involvement in Ethiopia might not be as clear. However, China is aware of the increasing significance of Ethiopia's geopolitical role in the horn of Africa and the Nile Basin upstream countries. The bilateral relations between China and Ethiopia which include a zero tariff for Ethiopian goods, debt cancellation, and joint infrastructure projects, have made them unique partners (Arsano, 2007).

China does not hesitate to step in and finance projects that might have uncertain long-term impacts when Western donors shy away from them. While China steps in with full support, other donors are still often focusing more on potential long-term negative environmental impacts of development rather than welfare impacts for poor upstream populations (Schüller and Asche, 2008).

The highlight of the Chinese financial support in Africa is that it is not related or linked to any particular objectives or standards that have to be met by the beneficiary country (Arsano, 2007). Unlike Western donors, China is less stringent on political reforms or economic obligations from their African counterparts, this makes their funds more accessible and much faster to obtain than Western donors. It also serves the interests of the African political elite in power and fosters the relationship with them to move on quickly with the hydropower projects. Therefore, the emerging hand of China represents a powerful alternative to "traditional" Western

donors.

The Zambezi River Basin

Sub-Saharan Africa has traditionally been a large recipient of international aid for development. This is still the case as large international organizations such as the World Bank and the United Nations have continued to fund dam projects in the region and along the Zambezi River. In recent years, the African Development Bank has also become a large supporter of dam projects on the Zambezi. Dam projects in Africa are a large part of their New Deal on Energy for Africa, which aims to achieve universal electrification for all of Africa by 2025 (African Development Bank, 2016).

Developing economies (particularly China),In order to meet its growing population, growing middle class, and the need for raw resources, have interjected themselves in many of the Southern African nations' economies. "New development finance is pouring into the Zambezi Basin from China, BRICS [Brazil, Russia, India, China, and South Africa] and transnational corporations" (Pearce, 2013). In the case of Zambia, the economic boost given by China has increased its capability to exploit its water resources. This is particularly troubling for Zimbabwe and Mozambique, who other than Zambia have the largest share of the Zambezi River.

Trends, Drivers, and Constraints: Selected Cases

Although riparian countries in each of our cases desire economic growth and face growing or changing energy demand, each case also faces unique challenges. Some riparians struggle for control over water resources between the upstream and downstream sections of the river, and must make way for cooperation or conflict among regional riparian powers. In other instances, large hydroelectric projects are perceived as a valuable source of renewable energy,

while other riparians begin to question the political, financial, and environmental risks involved in taking on new projects.

The Mekong River Basin: hydro hegemony

Power dynamics between upstream and downstream countries of the Mekong River Basin shape development in the region, but there are also opportunities for cooperation, including the export of electricity to neighboring countries. In the context of water resources of the Mekong River Basin, China serves as an upstream 'hydro hegemon' that can control the flow of the river, often via hydroelectric dam projects to generate electricity domestically. 'Hydro hegemony' refers to the power asymmetry between China and downstream neighbors Cambodia, Laos, Thailand, and Vietnam because of its water resources--in addition to containing the headwaters of the Mekong, the Tibetan plateau gives it abundant freshwater reserves (Han, 2017). These water resources can be manipulated to exercise power over downstream countries, with China able to control dry and rainy season flows of the river. Currently, there are six mainstream dams in China on the Lancang/Mekong River. According to Han, China "refused to become a full member of the commission due to fear of being subjected to MRC provisions on aquatic environmental issues and restrictions on dam building" (Han, 20`7). Despite expanding its solar and wind capacity, in the short term it is likely that China will continues its hydropower expansion.

There have been opportunities for both regional contestation and cooperation. In 1992, the Asian Development Bank (ADB) created the Greater Mekong Subregion, an economic cooperation program that later included a "Roadmap for Expanded Energy Cooperation" which would facilitate power trade among states (Middleton & Allouche, 2016). Trade with more affluent countries like Thailand and Vietnam meet their growing electricity demand, while

countries like Laos could earn revenue by exporting power. According to the Mekong Policy Project at the Stimson Center, countries in the basin like China, Myanmar, and perhaps Cambodia, will become energy exporters in the near future as they expand domestic capacity (Cronin & Weatherby, 2015). This shift from importers to exporters may foil Laos' plans for earning revenue from its neighbors, and may signal a slowdown in the rate of energy demand growth in the region.

Brazil: Transitioning away from mega dams

Unlike smaller developing economies like Ecuador or Laos, which seek to expand their production of hydropower, Brazil is slowing its growth in hydropower. Brazil expects to increase the proportion of wind and solar energy generation while slowing the relative growth in large hydropower capacity. In particular, on-shore wind is appealing as a form of renewable energy due to abundant wind resources in the northeastern part of the country. According to the 2026 PDE, Brazil aims to increase its installed capacity of wind from 10,000 MW to 28,500 MW by 2016. On a smaller scale, solar capacity would be increased from less than 100 MW to 9,660, or around 1,000 MW per year (PDE, 2016). Brazil has some infrastructure to support alternative renewables, but still faces barriers against a larger-scale rollout. At one point the Brazilian government supported energy auctions with long-term Power Purchase Agreements, had access to low-cost financing from BNDES, and was working on state level tax incentives for solar PV (Cuff, 2018). Energy sector officials currently believe that solar currently has uncompetitive deployment costs, though rates are falling in Brazil very quickly (PDE, 2026). While wind and solar capacity are increasing quickly, the amount of hydropower capacity will increase over the next decade at a much slower rate.

Climate change adaptation and mitigation efforts, along with the increased investment

potential, explain Brazil's shift towards solar and wind. The 2015 Paris Agreement from the United Nations Framework Convention on Climate Change outlines Brazil's Nationally Determined Contributions (NDCs) to mitigate greenhouse gas emissions. According to Brazil's NDC, "Brazil intends to commit to reduce greenhouse gas emissions by 37% below 2005 levels in 2025" (Brazil INDC, 2015). In addition, Brazil committed to adaptation measures such as more renewables in its energy mix, "expanding the use of renewable energy sources other than hydropower in the total energy mix to between 28% and 33% by 2030" and "increasing the share of renewables (other than hydropower) in the power supply to at least 23% by 2030, including by raising the share of wind, biomass and solar" (ibid). According to these commitments, relative to other renewables, the proportion of hydropower in the energy mix will stay stagnant or shrink in the coming years. This matches with 2024 PDE projections, where hydroelectric power shrinks from 68% to 57% of installed capacity over ten years, and the proportion of wind and solar installed capacity increases almost threefold. Rivers with seasonal flow like the Amazon, with reduced dry season energy production, as well as greenhouse gas emissions from dam reservoirs, may explain why large hydropower projects are not considered part of Brazil's renewable energy commitments with the UNFCCC.

Internal political factors contribute to some of the public shift away from large dams. Civil society, primarily indigenous groups and environmental activists, have used public protest to halt or stall dam construction by physically occupying dam sites. International actors have also been involved--Hollywood director James Cameron of the film *Avatar* became a spokesperson on behalf of the NGO Amazon Watch, supporting the Xingu indigenous group and speaking out against the dam (Phillips, 2010). Federal court cases and rulings from the environmental agency IBAMA have also delayed dam projects. In September 2015, IBAMA withheld the operating

license from the Belo Monte dam consortium Norte Energia until it completed mitigation projects such as sanitation systems and housing for displaced communities (Douglas, 2015). In January 2016, a federal court again suspended Norte Energia's operating license for failing to adequately provide for the indigenous groups affected by the dam construction (Watts, 2016). However, the license suspensions often delay operations only temporarily. In a holdover from the military dictatorship, the Brazilian government can implement a security suspension (suspensão de segurança), which allows a judicial decision to be overturned that causes 'grave damage to the public economy' or national security (Fearnside, 2017). Nearly every dam project would fall into this classification.

Massive corruption scandals such as the ongoing Lava Jato (Car Wash) scandal, which began in 2014, have had transnational and implications across many sectors of the economy and political sphere, touching state run oil company Petrobras, major construction company Odebrecht, former presidents Lula da Silva and Rousseff, current president Michel Temer, and many current and former public officials at the local, state, and national level. Odebrecht, whose portfolio includes 85 hydropower plants and is one of the construction contractors of the Belo Monte dam, pled guilty to giving bribes in exchange for government contracts and agreed in late 2016 to pay up to $2.6 billion dollars in fines (Watts, 2017).These scandals have increased public scrutiny of the dam industry, the construction sector, and politicians in general. Public participation and input on dam projects may include more imperfect and cursory consultation than the transparent negotiations suggested by the World Commission on Dams, but activists in Brazilian civil society are working to hold the government accountable, both on corruption and on compensation for dam-affected communities.

While climate change considerations and increased public scrutiny of corruption in the

construction sector may have shifted discussions of Brazil's energy portfolio, the economic recession in 2015 substantially decreased energy demand, halting or stopping new projects in their tracks.The economic recession had implications for solar and wind expansion as well. In August 2017, the Brazilian government canceled 25 wind and solar projects contracted to companies in the face of slump (Reuters, 2017). The firms cited reduced credit availability and slow recovery in the construction sector as reasons to beg off the deal. The temporary nature of the recession could mean that if energy demand increases, Brazil may again change course on its position on large dams and resume delayed or halted projects, such as dams in the Tapajos Basin.

Ecuador: The beginning of new dam construction

In Ecuador, as in many countries in the Amazon Basin with the exception of Brazil, the construction of dams and the shift to hydropower is in the early stages. Although the government's emphasis on renewable energy is fairly recent, with a particular focus on hydropower due to the untapped potential in the area, the development has happened quickly. Ten years ago, the country that was highly dependent on fossil fuels, which not only represented much of the power generation within Ecuador but also made up nearly half of all exports (IHA 2017). With a new constitution signed in 2008, which focuses on indigenous environmental rights and clean energy, the government has encouraged a transition alternative energy, with an ambitious goal of 90% of electricity sourced from hydro (Norton Rose Fulbright, 2016; IHA 2017). In pursuit of this goal, 8 hydroelectric dam projects have been constructed or planned over the last 3 years, the largest of which is Coca Codo Sinclair, which cost $2.2 billion USD and is generating almost 1,500 MW of power (Energia16, 2015). With more projects in the works, and little focus on other forms of renewable energy, the construction of dams in Ecuador is expected to continue at a rapid pace.

The Nile Basin: Changing Hydro-politics

Even though Egypt has been able to preserve its hydro-political hegemonic status for decades, this position of power within the Basin is now being under scrutiny. Ethiopia, Kenya, Rwanda, Tanzania, Uganda, Burundi and the Democratic Republic of the Congo signed the new cooperation framework agreement (based on IWRM) in 2010 (Elwardany, 2016). Such a step shepherds a clear shift in the hydro-hegemonic dynamics in the basin. Since upstream countries are having more political and social stabilities, they are poised to exploit more water from the Nile for their own economic benefit and lean towards the formation of coalitions to dominate the hydro-politics. The creation of stronger multilateral ties between upstream riparians in the Nile can either set a conflict between upstream and downstream countries in motion or open the door for diplomacy and cooperation to resolve issues amicably.

The Zambezi River Basin: Out with the old, in with the new

The Zambezi River has a few unique trends/events that are not shared with the other river basins in this report. First, the Kariba Dam, which borders Zambia and Zimbabwe, is deteriorating and is in need of a rehabilitation project to avert a catastrophic collapse. Second, since international organizations are still willing to provide funding for dams along the Zambezi there has been no move to switch to internal or regional funding for dam projects.

The Kariba Dam was built over 50 years ago and in that time has been a major source of power for the whole Southern African region. However, in recent years the dam has begun to deteriorate. This has reduced the energy generation capability of the dam and unless rehabilitated, the dam could collapse, endangering millions of local inhabitants. The Kariba Dam rehabilitation project, with estimated costs of almost $300 million, is also an example of the availability of funding from outside sources. The table below shows the major funders for this

project (Wishart, 2015).

Financing for the Kariba Dam Rehabilitation Project

Organization	Financing	
Zambezi River Authority	US$19.2 m	-
Africa Development Bank	US$75 m	Loan & Grant
European Union	US$100 m	Grant
Swedish Government	US$20 m	Grant
The World Bank Group	US$75 m	Loan

Source: Wishart, 2015

Transboundary Governance and Water Management

In order to achieve development outcomes that are sustainable and equitable, the management of water resources across national and regional boundaries is essential across many sectors, including hydropower development on rivers that cross borders. Integrated Water Resources Management is an international framework based on principles of social equity, economic efficiency, and ecological sustainability. IWRM is "the process that promotes the coordinated development and management of water, land, and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Global Water Partnership, 2011). Many regional water management organizations use aspects of this framework in their work. Although some dams are contracted on an individual project basis, dam development is closely intertwined with the regional management of water resources because of the potential basin-wide impacts.

Despite the unique social, political, and economic factors driving or constraining dam construction in individual countries, the connectivity of rivers in basins between riparians means that issues and benefits cross political boundaries and need to be dealt with cooperatively.

Mekong River Basin

As a result of upstream dams in China as well as other mainstream development on the river, the major transboundary issues of the Mekong Basin are around the food-water-energy security nexus. As mentioned previously, millions of people rely on the basin for livelihoods from fisheries and floodplain agriculture. At the same time, demand for energy is increasing as populations grow and rural areas become electrified. Through transboundary water management organizations and regional economic cooperation programs, riparians in the Mekong are working to balance the economic investment that hydroelectric dams can bring to their countries with the basinwide effects on the ecosystem and localized effects on river communities.

On the Mekong River, the Mekong River Commission (MRC) serves as an interstate organization that promotes an equitable sharing of benefits and risks among all countries of the basin using research, monitoring, and modeling to manage water resources. One of its primary objectives is to "promote optimal and well-balanced development of the Basin while ensuring the equitable sharing of benefits among all users of Basin water and related resources" (MRC, 2018). The agreement establishing the organization, the Mekong Agreement, was created in 1995 by Cambodia, Laos, Thailand, and Vietnam. The 1995 agreement included procedures for Notification, Prior Consultation, and Agreement as well as articles on "reasonable and equitable use" and "prevention and cessation of harmful effects", all while acknowledging the sovereignty of the member states (Chapter III Articles 4, 5, 7, 1995). The MRC operates under a dozen thematic areas involving development and management of the basin, including sustainable

hydropower. Among other international river management organizations, the MRC is one of the more established, and leads the way in research.

As an international organization, the MRC can reduce transaction costs in negotiations involving conflict of water resources between states by being a platform to facilitate consensus and cooperation among member states. The organization pools technical resources, knowledge, and measurement and evaluation on river projects in order to sustainably develop the region. However, the MRC faces limitations, mainly due to the Lower Mekong Basin's proximity to China and the organization's limited mandate. China is not a member of the MRC, but as an upstream country, can substantially impact dam development and water resources that have negative impacts on the downstream parts of the Mekong. In addition to China's economic and political power in the region is the Commission's lack of legally binding authority, which prevents the MRC from making regulations, or from member states unilaterally building dams despite opposition from other members.

Despite its limitations, the MRC provides an important role in influencing policy and support regional cooperation. The Commission provides research and sustainability assessments that go more in-depth than the environmental impact assessments of dam developers. With its research and evaluation capabilities, as well as its cooperative planning efforts with member states, the MRC has legitimacy as an evidence-based institution that advocacy organizations and activists may not have. However, because it is funded by Western donors, the MRC may not be considered legitimate in the lower Mekong by a powerful neighbor--China.

In the MRC, China and Myanmar are not full members, but serve as upstream "Dialogue Partners," essentially observers. The working relationships between these two countries and the MRC primarily involve data sharing of river flow and rainfall data (MRC-Upstream Partners,

2018). China has its own transboundary organization, the newly formed Lancang-Mekong Cooperation Mechanism. The LMCM's development goals are to synergize China's infrastructure development strategy, the Belt and Road Initiative, with the ASEAN Community Vision for 2025 (China Daily, 2018). Established in January 2018, the mechanism's main principles are consensus, mutual consultation and coordination, and respect for international and domestic laws. Though mentioning water security, flood and drought management, and technological cooperation of water resource management, the plan of action does not mention dam development specifically.

The MRC's lack of regulatory and veto power means that the MRC does not have direct control the development on the Mekong. Among the MRC member states, Cambodia and Laos in particular have pursued dam projects, primarily to produce power for export. Critics of the MRC have questioned why the commission was unable to resolve disputes involving dam construction. In particular, the public participation processes for the Xayaburi and Don Sahong dams were seen as failures of the MRC's Procedures for Notification, Prior Consultation, and Agreement. In 2011, the government of Laos announced its proposal for the Xayaburi Dam. Although the downstream countries of Cambodia and Vietnam expressed concern over the dam's impacts, Laos began construction of the dam a year and a half later. This "had a serious corrosive effect on regional trust" of the notification and consultation process and damaged the MRC's credibility (Cronin & Weatherby, 2015).

Many of MRC's limitations as a regional organization are not unique to the management of water resources, but rather are a function of being a transnational organization. Without enforcement mechanisms or regulatory power, the principle of state sovereignty privileges national interests, potentially over regional impacts.

The MRC is funded through member country contributions and development partners such as the European Union, World Bank, Japan, and the United States. In 2012, over 90% of MRC's funding came from external donors (Gerlak & Haefner, 2017). Currently, the MRC is undergoing a transition to "streamline" the organization to become entirely funded by member countries gradually by 2030. On the one hand, the MRC would become a financially independent regional organization, no longer reliant on resources from donor countries. However, this transition also means the organization would trim its budget by two-thirds in the same time period, which would substantially limit the scope of work the organization could achieve (MRC Strategic Plan, 2016-2020). The restructuring, termed 'riparianization,' decentralizes and localizes the staffing, budgeting, and programmatic functions of the organization. This comes from calls for reform, "pressure from donor community to be more self-sufficient," and withdrawal of donors due to rapid development of dams on the river (Gerlak & Haefner, 2017).

While the MRC is limited as a regional organization in its capacity to enforce the behavior of its member states, it provides definite and clear advice on dam development in the basin by specifically highlighting sustainable hydropower as one of its thematic areas. In contrast, other transboundary water management organizations discuss water security more generally, without mention of dams. The restructuring of the MRC may decrease the resources it has available to provide technical support through research and impact assessments, as contributions from member states are dependent on their growth prospects.

The Lower Mekong Basin's proximity to China, and China's growth in the region, has already altered the relationship between the member states and China. It is likely through development of projects on the Mekong River, in addition to its investments in the region, that China will gain more influence over the Mekong in the name of enhanced regional cooperation.

Amazon Basin

The Amazon River Basin, stretching across Brazil, Ecuador, Colombia, Bolivia, Peru, Suriname, Guyana, and Venezuela, is the largest river basin in the world (Braga et. al, 2011). The basin contains more than 150 dams, with many more planned or under construction (Fraser 2015).

ACTO was formed as part of an amendment to the Amazon Cooperation Treaty, which was signed by all 8 Amazon Basin countries in 1978, in an effort to ensure sustainable development practices throughout the basin (Braga et. al, 2011). In 1998, when ACTO was created, the countries began a more structured dialogue about sustainability, water management, and other regional development plans (Braga et. al, 2011). The organization has not focused on dams specifically, but recent projects, such as the GEF Amazon Project are centered on identifying issues in each country and establishing a framework for Integrated Water Resource Management (IWRM) (ACTO 2016). Climate change is seen as an important consideration in creating a cooperative plan of action, and a cross-border diagnostic analysis (TDA) has been conducted in each country to analyze climate vulnerability and how this relates to IWRM (GEF, 2018). Through this TDA, ACTO was able to identify 10 priority cross-border issues to be addressed by the Strategic Action Plan (ACTO 2016). These transboundary problems included loss of biodiversity, deforestation, erosion/sedimentation, land use change, extreme hydroclimatic events, creating an integrated regional information platform, strengthening scientific knowledge, regional and cultural education, water pollution, and regional/institutional frameworks (GEF 2017). The concept of the project was approved in November 2017, but the project has not yet been approved for implementation (ACTO, 2018).

Although ACTO and the ongoing GEF project does not focus on hydroelectric dams in

their research, it is clear that the many dams being built on the Amazon Basin have had and will continue to have an effect on many of the transboundary issues the GEF project aims to address. The GEF project does include hydropower as part of one of their outputs for the project, as meeting Sustainable Development Goals for each country is one of their objectives. One output of their Strategic Action Plan is inter-ministerial and expert dialogue roundtables, which will be focused on creating resilient infrastructure and hydropower as a potential source of sustainable energy, in order to address SDG 9, which entails building resilient infrastructure and promoting sustainable industrialization (GEF, 2017). Since these roundtables have yet to be implemented, it's not clear what plans will be made or agreed upon in regard to hydropower dams, but since hydroelectricity is the largest and cheapest form of energy in the Amazon (Fraser, 2015), it seems likely that dams will be viewed as a positive way to increase renewable energy, as this has generally been the consensus of national governments. At this time, there is not a transboundary organization that has created guidelines, agreements, or exercised control over dam building in the Amazon Basin, but there is potential for ACTO to include hydroelectric dams in its analysis of the environmental, social, and political aspects of Integrated Water Resource Management.

Nile Basin

The river Nile is the longest river in the world extending over 6,670 km in Africa. The Nile goes through 11 different countries. It has three main sources: Lake Victoria, the largest freshwater lakes in the world, from which the White Nile originates; the Blue Nile; and the Atbara River, both are derived in Ethiopia. The upstream countries are: Burundi, the Democratic Republic of Congo, Eritrea, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda. There are three downstream countries: Egypt, Sudan and South Sudan (World Bank, 2000).

The case of the river Nile is especially interesting in terms of runoff management and the

transboundary relations between the riparian countries. In most of the river basins, upstream countries are able to control the runoff discharge as they have the superior geographical location, like the case of China in the Mekong river basin. For the case of the Nile, however, the riparian countries have a different hydropolitical configuration. The runoff is mostly controlled by the downstream countries, especially the most downstream country of Egypt. This case makes it very interesting to study the river Nile basin water management between its riparian countries.
From the cases of water management between riparian countries, we often see that conflict and cooperation can coexist. The dichotomy of black vs white does not really control the hydropolitical situation of riparian countries due to the presence of a lot of grey area that factors into the relationships. Collective problems are generally easier to address than problems related to the upstream-downstream relation, as all riparians seem to recognize the urgency related to these sorts of problems. The Nile river has always been a source of political tension and high intensity conflict between the countries that have most runoff from the river i.e. Egypt, Sudan, South Sudan and Ethiopia.

The two most powerful riparian countries in the river basin, Egypt and Ethiopia, are facing dynamic changes ranging from socioeconomic changes, such as population growths and increasing poverty, to environmental changes, such as climate change and water insecurity. These changes profoundly affect the bilateral relationships between both countries. The Ethiopian Grand Renaissance dam has been met with strong resistance by the Egyptian government. Egypt claims that the dam will shrink the size of the runoff quantity in the Nile and will have devastating effects on agriculture especially during the first three years of filling the dam's reservoir.

The following table summarizes the socioeconomic and water-use related figures on

Egypt and Ethiopia. The table highlights the major difference between economic productivity in both countries in terms of GDP even though both countries have fairly similar demographic and geographic characteristics.

Indicator	Egypt	Ethiopia
Total land area (sq. km)	995,450.00	1,000,000.00
GDP (US$ billions)	162.82	26.49
GDP growth (annual %)	7.10	11.30
Agricultural sector (% of GDP)	14.10	42.70
Official Development Assistance (ODA) and official aid (million US$) in 2005	995.00	1,916.00
ODA and official aid (million US$) in 2000	1.327	686.00
Population total (millions)	81.53	80.71
Population rural (% of total population)	57.30	83.00
Population growth rate (%)	1.80	2.60
Population involved in agriculture (% in 2005)	30.90	80.20
Access to improved water source (%)	98.00	42.00
Life expectancy at birth (total years)	70.20	55.40
Prevalence of undernourishment (% of population in 2005)	5.00	46.00

Source: World Bank. 2008.

The Nile Basin Initiative:

Since 1999, comprehensive efforts have been made toward the development of a new Nile Basin regime called the Nile Basin Initiative (NBI). The NBI is a partnership initiated and run by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states (NBI 2010). All riparian countries of the Nile Basin are represented in the NBI, except for Eritrea, which has only an observer role. The objectives of the NBI aim at developing a Nile Basin water resources management system that ensures peace and security for all the people of the riparian countries (NBI, 2010). They also aim at fostering cooperation and joint action between all riparians, seeking win-win gains with an overarching goal to eradicate poverty and promote economic prosperity basin wide. According to the NBI, all the program results shall move from planning to action in a timely and efficient fashion to ensure immediate

results for the peoples of the riparians (2010).

Zambezi River Basin

The first model for cooperative water management and dam building along the Zambezi River was created in the 1950's under British colonial rule. Members of the British Commonwealth, some self-governed and some under direct British rule, came together to build the Kariba Dam along the borders of Zambia and Zimbabwe (Kampanje-Phiri, 2016). This early dam was seen as essential by the colonial ruling elite for mining, agriculture, industry, and the development of urban center. To meet these needs, the British built infrastructure that connected much of the SADC (the most important of which was South Africa) and set up a system of electricity transference that is still in place today, much of which has been upgraded in recent years (Soderbaum, 2015).

After the 6 riparian countries (Zambia, Zimbabwe, Mozambique, Angola, Namibia, and Botswana) gained independence the river resources were utilized mostly along national boundaries in order to meet the growing needs of the fledgling nations. An outside expert on integrated water resource management sees it the following way:

> Each riparian state monitors, assesses, plans, develops, conserves and protects the Zambezi River resources within its own territory. The utilization of the water resources is done at the country level with little consultation and co-operation among riparian states. This situation is not conducive to the effective management of shared waters since each of the countries uses different standards. . . . The Zambezi River basin represents an arena of different national interest in which the various riparian states are developing diverging policies and plans that are usually not compatible. Upstream/downstream users are often not keen to consider the problems of each other (Breslin, 2002)

This style of water resource management where each nation focused on their part of the river clearly had some problems. This kind of state-centered water management often results in environmental degradation, resource waste, and unrealized potential. This competitive

mismanagement led to underutilized potential and is one major reason the riparian nations came together and signed an agreement to implement the action plan for the Environmentally Sound Management of the Common Zambezi River System (ZACPLAN). The ZACPLAN agreement was the first attempt to see the river as an international body of water as opposed to a river comprised of different sections that were managed according to national interest. However, the ZACPLAN was only an agreement between member states to implement environmentally sound water resources management. It was shown to be largely ineffective because it lacked any legal or institutional framework (Soderbaum, 2015). This came seventeen years after the signing of ZACPLAN, when an agreement was signed to establish the Zambezi Watercourse Commission (ZAMCOM). The ZAMCOM is a regional instrument mandated to lead and coordinate international water resources management in the Zambezi River Basin. The agreement was ratified in 2011, which lead to the establishment of ZAMCOM as the legal institution for coordinating international water resource management in the Zambezi River Basin. It also serves as a framework for promoting the equitable utilization, efficient management, and sustainable development of the water resources (Kampanje-Phiri, 2016). As stated in the ZAMCOM website, the major factors leading to the agreement and the key areas of interest for the commission are:

- The scarcity and the value of water resources in the southern African region and the need to provide the people in the region with access to sufficient and safe water supplies;
- The significance of the Zambezi Watercourse as a major water source in the region, as well as the need to conserve, protect and sustainably utilize its resources;
- The commitment to the realization of the principles of equitable and reasonable utilization as well as the efficient management and sustainable development and management of the basin's water resources;
- The desire to extend and consolidate existing relations of good neighbourliness and cooperation amongst the Zambezi Riparian States on the basis of existing international water instruments.

Not only did the ZACPLAN contribute to the ZAMCOM Commission, but it also contributed to water management agreements for the wider South African region. In 1995 the 15 member states of the SADC enacted the Protocols on Shared Water Policy, which were later revised in 2000. These protocols signify the first cooperative action by the member states of the SADC to regulate and enforce shared water resource management in the whole Southern African Region. An excerpt from the protocols explains it in the following way:

> . . . unity and coherence of each shared watercourse and in accordance with this principle, undertake to harmonize the water uses in the shared watercourse and to ensure that all necessary interventions are consistent with the sustainable development of all Watercourse States and observe the objectives of regional integration and harmonization of their socio-economic policies and plans (SADC 2000).

The protocols were not only an agreement on the use of shared watercourses, but also set up institutions and a legal framework. One major function of the institutions and legal framework was to act as a mediator and forum for any disputes that may arise from water resource management.

Of the six riparian countries, Zambia plays a key role in any cooperative management scheme. Zambia has 41% of the Zambezi River Basin, Zimbabwe has 19%, Mozambique and Angola has 11%, and Botswana has 6% (Kampanje-Phiri, 2016). Zambia and Zimbabwe having 60% of the Zambezi River Basin within their countries has led to these two countries having a majority of the hydroelectric dams. The governments of these two countries have created the Zambezi River Authority (ZRA), a semi-governmental corporation that owns and operates a large number of dams on the river. The ZRA owns and operates the Kariba Dam and will do the same for the proposed Batoka Gorge Dam. Owning and operating two of the largest dams on the river has made the ZRA a big player in water management on the Zambezi River, as well as a

power supplier for the SADC.

More recently, the World Bank has initiated the Zambezi River Basin Program. This program was designed to respond to Southern Africa's development needs. The $2 billion program, financed by the World Bank, is aimed at facilitating dialogue between riparian countries and to drive development of water sources for sustainable growth. The program also includes a long-term partnership between ZAMCOM and the ZRA to empower regional bodies with institutional mechanisms and information platforms to better manage shared water resources and advance high-priority infrastructure investments (Hoel, 2015).

Analysis & Conclusion

Some regions are experiencing a slowdown in hydro dam construction, while others are just getting started.

- Internal politics and economy: Brazil, Ethiopia
- Appeal to foreign investors: Zambezi, Ecuador and Ethiopia
- Feasibility of alternative forms of energy: Egypt, Brazil

Throughout this paper, we have seen that internal politics and economic development incentives can tremendously push for the building of hydropower projects such as dams, such as the Renaissance Dam in Ethiopia. In Brazil, however, there is a consensus on the shift towards clean sources of energy for power generation that is both supported by the people and the government. This contradiction of public opinion across the world makes it very hard to reach a clear cost-benefit analysis for hydroelectric projects such as dams.

In addition, we have also seen that international donor funders do not have a firm stance on dam construction. Western donors are skeptical about funding hydropower projects in the Global South. Their Chinese counterparts, however, have shown strong interest in building dams and funding hydropower projects not only in the Mekong River Basin but also in other river

basins, particularly in sub-Saharan Africa.

Alternative sources of energy are very attractive for sustainable development efforts. Brazil and Egypt, for example, have shown a dedicated direction towards solar, wind and nuclear power to generate electricity across their cities. Yet, the question about water scarcity is still unsolved. Alternative sources of energy can in fact substitute other traditional power generation methods. But what about the water that has been reduced drastically due to climate change?

With increasing global attention to changing climate patterns, dams emerge as a solution to some but part of the problem to others.

- Some states only superficially address environmental and social impacts
- Institutions that support public participation can create more political power around the issue

In many parts of the Global South dams are still seen as signs of economic development and a way to meet rising energy needs. This thought is reinforced by international organizations and other world powers, such as China, who are willing to fund large dam projects. However, changing weather patterns brought on by climate change are affecting the productive capabilities of many rivers. Damming these rivers not only inhibits the future productivity of the rivers for more dams but also affects the ability of local populations to utilize the river as a source of their livelihood.

Transboundary organizations are one way that these concerns can be addressed. Even if some of these organizations were formed with the aim of managing the water resources in a way that is fair for all riparian nations. However, outside forces and national interests have thus far inhibited the ability of these organizations to function as stewards of the rivers and its resources.

Transboundary organizations (TBOs) have been primarily supported by international institutions, but there is a push for state and regional ownership and participation.

- This fosters regional self-sufficiency, but limits funding available
- Power dynamics between riparians complicate regional cooperation

Many transboundary water management organizations were set up with the help and funding of international bodies, especially the UN. Yet, these types of arrangements mean that the organizations need to adhere to the rules and regulations of the outside body and are subject to oversight. This has led many TBOs to move towards self-funding and self-sufficiency. However, this typically means that the TBOs have less financial capital to work with. Subsequently, this inhibits the ability of the TBOs to manage the water resources. An example of this is the Mekong River Commission, which is gradually limiting funding from outside sources, which will result in a substantial overall budget reduction.

Not only do funding sources complicate the functionality of TBOs, but it also complicates regional power dynamics. This is shown in the Nile case with the upstream/downstream contention between Ethiopia and Egypt. With no regional cooperation the water resources are subject to the national interests of the riparian nations, which could negatively impact the productive capability of the river for all riparian nations.

Over the past few decades, hydroelectric dam projects have been seen as a way for countries in the Global South to gain much needed economic development while also meeting their energy needs. More recently there have been changes in the hydro-dam landscape, brought on by the ideas espoused by integrated water resource management. IWRM seeks to frame transboundary rivers as international bodies that require regional cooperation (in the form of TBOs) to manage the water resources sustainably. This focus on sustainability have induced some transboundary organizations to move away from hydroelectric dams in favor of other

renewable energy sources, while others have been able to gain more international funding for more hydroelectric dams. Whether or not there is a move towards more or fewer hydroelectric dams, the focus on sustainability, coupled with the effects of climate change, has brought to light many of the adverse environmental effects dams have on the productivity of rivers. As more attention is given to these effects the future reliability of hydroelectric energy production will be more at risk and more countries in the Global South will have to consider other sources of renewable energy.

References

ACTO. (2016). Proyecto GEF Amazonas. Retrieved from http://www.otca-oficial.info/projects/details/3

ACTO. (2018). Estructuro el Proyecto. Retrieved from http://otca.info/gef/sobreoprojeto

African Development Bank Group. (2016). *New Deal on Energy for Africa* (p. 16). African Development Bank. Retrieved from https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Brochure_New_Deal_2_red.pdf

Anja Kristina Martens. (2011). Impacts of Global Change on the Nile Basin Options for Hydropolitical Reform in Egypt and Ethiopia. *INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE*.

Ansar, A., Flyvbjerg, B., Budzier, A., & Lunn, D. (2014). Should we build more large dams? The actual costs of hydropower megaproject development. *Energy Policy*, *69*, 43–56.

Arne Hoel. (2015). *Collaborative Management of the Zambezi River Basin Ensures Greater Economic Resilience*. The World Bank. Retrieved from http://www.worldbank.org/en/news/feature/2015/09/10/collaborative-management-of-the-zambezi-river-basin-ensures-greater-economic-resilience

Ashok Swain. (2011). Challenges for water sharing in the Nile basin: changing geo-politics and changing climate. *Hydrological Sciences Journal*, *56*(4), 688–702.

Bahar, H. (2017). *Renewables 2017: Analysis and Forecasts to 2022*(Market Report Series). International Energy Agency.

Belo Monte Dam, Brazil. (2017, October 3). Retrieved from https://www.banktrack.org/project/belo_monte_dam

Biller, D. (2018, April 24). China Expands Brazil Frontier as Investment Grows During Crisis. *Bloomberg*. Retrieved from https://www.bloomberg.com/news/articles/2018-04-25/china-expands-brazil-frontier-as-investment-grows-during-crisis

Braga, B., Varella, P., & Goncalves, H. (2011a). Transboundary Water Management of the Amazon Basin. *International Journal of Water Resource Development*, *27*(3). Retrieved from https://www.tandfonline.com/doi/abs/10.1080/07900627.2011.595382

Braga, B., Varella, P., & Goncalves, H. (2011b). Transboundary Water Management of the Amazon Basin. *International Journal of Water Resources Development*, *27*(3), 477–496.

Breslin, S., H., G. D. (2002). *Microregionalism and World Order* (1st ed.). New York: Palgrave Macmillin. Retrieved from https://books.google.com/books?id=oMxsCwAAQBAJ&pg=PA62&dq=Microregionalism+and+World+Order+sources+cited&hl=en&sa=X&ved=0ahUKEwiz1v3c9fvaAhWLiYMKHX7iCqYQ6AEIKzAA#v=onepage&q=Microregionalism%20and%20World%20Order%20sources%20cited&f=false

BNDES and the New Development Bank, "the BRICS' bank," carry out the 1st disbursement in Brazil. (2018, April 18). Retrieved from https://www.bndes.gov.br/SiteBNDES/bndes/bndes_en/Institucional/Press/Destaques_Primeira_Pagina/20180418_bndes_brics_bank.html

Brazil cancels 25 wind, solar power projects at request of firms. (2017, August 28). *Reuters*. Retrieved from https://www.reuters.com/article/us-brazil-power-renewables/brazil-cancels-25-wind-solar-power-projects-at-request-of-firms-idUSKCN1B82G4

Brazil GDP Growth Rate. (2018). Retrieved from https://tradingeconomics.com/brazil/gdp-growth

Business Sweden. (2016). *Energy Sector in Zimbabwe*. Retrieved from https://www.business-sweden.se/globalassets/energy-sector-in-zimbabwe.pdf

Controlling shareholders looking to sell stake in Norte Energia. (2017, February 10). *Thomson Reuters*. Retrieved from https://www.reuters.com/article/belo-monte-ma/controlling-shareholders-looking-to-sell-stake-in-norte-energia-paper-idUSL1N1FV0FK

Cronin, R., & Weatherby, C. (2015). *Time for a New Narrative on Mekong Hydropower* (Letters from the Mekong). The Stimson Center. Retrieved from https://www.stimson.org/sites/default/files/file-attachments/Letters_from_the_Mekong_Oct_2015.pdf

Cuff, M. (2018, March 20). Sunshine rollercoaster? Brazil tipped for solar boom. *BusinessGreen*. Retrieved from https://www.businessgreen.com/bg/analysis/3028740/sunshine-rollercoaster-brazil-tipped-for-solar-boom

DAMS AND DEVELOPMENT A NEW FRAMEWORK: THE REPORT OF THE WORLD COMMISSION ON DAMS. (2000). *World Commission on Dams*.

Dams in Amazonia. (2018). Retrieved from http://dams-info.org/en

Draft Master Plan for Electrcity. (2012). Retrieved from http://www.edm.co.mz/index.php?option=com_content&view=article&id=379%3Aapresentadodraftdoplanodirectorelectricidade20122027&catid=53%3Anoticias&Itemid=78&lang=en

Duke Energy to sell its Brazilian business to China Three Gorges Corporation for $1.2 billion enterprise value. (2016, October 10). *Duke Energy New Center*. Retrieved from https://news.duke-energy.com/releases/duke-energy-to-sell-its-brazilian-business-to-china-three-gorges-corporation-for-1-2-billion-enterprise-value

Dean Kampanje-Phiri. (2016, July 10). *International Water Management in the Zambezi River Basin*. Uiversity of Bergen. Retrieved from http://bora.uib.no/bitstream/handle/1956/15986/dr-thesis-2016-Dean-Kampanje-Phiri.pdf?sequence=1

Dobrotkova, Z., & Waldron, M. (2012). *Renewable Energy Medium-Term Market Report 2012*. International Energy Agency.

Dollar, D. (2015, July 15). China's rise as a regional and global power: The AIIB and the 'one belt, one road.' *Brookings Institute*. Retrieved from https://www.brookings.edu/research/chinas-rise-as-a-regional-and-global-power-the-aiib-and-the-one-belt-one-road/

Douglas, B. (2015, September 23). Brazil threatens to withhold licence for Belo Monte dam over mitigation worries. *The Guardian*. Retrieved from https://www.theguardian.com/world/2015/sep/23/brazil-belo-monte-dam-operating-licence-withheld

Energia16. (2015). Hydroelectricity, the key for the Ecuadorian future. Retrieved from https://www.energia16.com/hydroelectricity-the-key-for-the-ecuadorian-future/?lang=en

Fearnside, P. (2017, September 20). Amazon dam defeats Brazil's environment agency. *Mongabay*. Retrieved from https://news.mongabay.com/2017/09/amazon-dam-defeats-brazils-environment-agency-commentary/

Fearnside, P. M. (2016). Brazil's Belo Monte Dam: Lessons of an Amazonian resource struggle. *Journal of the Geoographical Society of Berlin*, *148*(2–3), 167–184.

Fraser, B. (2015). Amazon Dams Keep the Lights On But Could Hurt Fish, Forests. Retrieved from https://news.nationalgeographic.com/2015/04/150419-amazon-dams-hydroelectric-deforestation-rivers-brazil-peru/

Fred Pearce. (2013, September 12). Zambezi: The Mekong's diplomatic debacle on repeat. Retrieved from https://wle.cgiar.org/thrive/2013/09/12/zambezi-mekongs-diplomatic-debacle-repeat

Fredrik Soderbaum. 2015. “Rethinking the Politics of Transboundary Water Management: The Case of the Zambezi River Basin.” *International Journal of Water Governance* 1(12): 12. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2678955.

Gatehouse, Mike. 2017. “The Amazon Be Dammed: Ecuador’s China Connection.” *Latin America Bureau*. https://lab.org.uk/the-amazon-be-dammed-ecuadors-china-connection/.

GEF. 2017. “GEF-6 Project Identification Form.” *The GEF*. https://www.thegef.org/sites/default/files/project_documents/9-29-17_-_PIF_doc.pdf.

———. 2018. “Implementation of the Strategic Action Programme to Ensure Integrated and Sustainable Management of the Transboundary Water Resources of the Amazon River Basin Considering Climate Variability and Change.” *GEF Project*. https://www.thegef.org/project/implementation-strategic-action-programme-ensure-integrated-and-sustainable-management.

Gerlak, Andrea K., and Andrea Haefner. 2017. “Riparianization of the Mekong River Commission.” *Water International* 42(7): 893–902.

Global Water Partnership. 2011. “What Is IWRM?” *www.gwp.org*. https://www.gwp.org/en/GWP-CEE/about/why/what-is-iwrm/.

Goodland, Robert. 2010. “Viewpoint: The World Bank Versus the World Commission on Dams.” *Water Alternatives* 3(2): 384–98.

Hellenic Shipping News. 2018. “Ecuador’s Energy Mix Is Dominated by Oil, Although Its Challenging Investment Environment and Lack of Domestic Refining Capacity Limit Oil Revenues.” https://www.hellenicshippingnews.com/ecuadors-energy-mix-is-dominated-by-oil-although-its-challenging-investment-environment-and-lack-of-domestic-refining-capacity-limit-oil-revenues/.

Hensengerth, Oliver. 2014. *Evolution of Dam Policies: Evidence from the Big Hydropower States*. ed. Waltina Scheumann. Springer.

Hivos. 2009. “Mozambique: Energy Profile.” https://hivos.org/sites/default/files/mozambique_profile.pdf.

Hydropower Projects: Brazil. (2018). Retrieved from http://www.worldbank.org/en/topic/hydropower/projects/all?qterm=brazil&z=&x=0&y=0

IEG Public Sector Evaluation, World Bank. (2015). *PROJECT PERFORMANCE ASSESSMENT REPORT BRAZIL: FIRST PROGRAMMATIC DEVELOPMENT POLICY LOAN FOR SUSTAINABLE ENVIRONMENTAL MANAGEMENT* (PROJECT PERFORMANCE ASSESSMENT REPORT No. 89848) (pp. 1–200). Retrieved from http://ieg.worldbankgroup.org/sites/default/files/Data/reports/brazil-sem-dpl-ppar.pdf

IHA. 2017. "Ecuador." *International Hydropower Association*. https://www.hydropower.org/country-profiles/ecuador.

International Energy Agency. (2011). *World Energy Outlook 2011*. Retrieved from https://www.iea.org/publications/freepublications/publication/WEO2011_WEB.pdf

International Hydropower Association. (2016). *Hydropower Status Report 2016*. London.

Ingram, Elizabeth. 2016. "Itaipu Hydro Production Surpasses Three Gorges in 2015." *Hydroworld.com*. https://www.hydroworld.com/articles/2016/01/itaipu-hydro-production-surpasses-three-gorges-in-2015.html.

Jacques Leslie. 2016. "One of Africa's Biggest Dams Is Falling Apart." *The New Yorker*. https://www.newyorker.com/tech/elements/one-of-africas-biggest-dams-is-falling-apart.

Kakonen, Mira. 2009. *Contested Waterscapes in the Mekong Region: Hydropower, Livelihoods and Governance*. eds. Francois Molle and Tira Foran. London: Earthscan.

Marcus Wishart. 2015. *The Kariba Dam Rehabilitation Project: Fact Sheet*. The World Bank. http://www.worldbank.org/en/region/afr/brief/the-kariba-dam-rehabilitation-project-fact-sheet.

McCully, Patrick. 2001. *Silenced Rivers: The Ecology and Politics of Large Dams*. 2nd ed. London: Zed Books.

McDonald, Kristen, Peter Bosshard, and Nicole Brewer. 2008. "Exporting Dams: China's Hydropower Industry Goes Global." *Journal of Environmental Management*.

McElhinny, Vincent. 2009. "World Bank DPL to Brazil: Moving Money or Mainstreaming Environmental Sustainability?" *Inesc Instituto de Estudos Socioeconômicos*. http://www.inesc.org.br/library/articles/world-bank-dpl-to-brazil-moving-money-or-mainstreaming-environmental-sustainability.

Mekong River Commission. (2018). Retrieved from http://www.mrcmekong.org/

Merme, Vernon, Rhodante Ahlers, and Joyeeta Gupta. 2014. “Private Equity, Public Affair: Hydropower Financing in the Mekong Basin.” *Global Environmental Change* 24: 20–29.

Middleton, Carl, and Jeremy Allouche. 2016. “Watershed or Powershed? Critical Hydropolitics, China and the ‘Lancang-Mekong Cooperation Framework.’” *The International Spectator* 51(3): 100–117.

Ministry of Mines and Energy. (2014). *PLANO DECENAL DE EXPANSÃO DE ENERGIA 2024 (Ten Year Energy Expansion Plan)*. Brazil.

Moore, Deborah, John Dore, and Dipak Gyawali. 2010. “The World Commission on Dams +10: Revisiting the Large Dam Controversy.” *Water Alternatives* 3(2): 3–13.

Nile Basin Initiative. (n.d.). Retrieved from http://www.internationalwatersgovernance.com/nile-river-basin-initiative.html

Norton Rose Fulbright. 2016. “Renewable Energy in Latin America: Ecuador.” *Norton Rose Fulbright*. http://www.nortonrosefulbright.com/knowledge/publications/134775/renewable-energy-in-latin-america-ecuador.

Organisation for Economic Co-operation and Development. 2004. “DEVELOPMENT AND CLIMATE CHANGE IN EGYPT: FOCUS ON COASTAL RESOURCES AND THE NILE.” *Organisation for Economic Co-operation and Development*.

Ortiz, Gonzalo. 2010. “Chinese Mega Loan for Dam Draws Fire.” *Inter Press Service*. http://www.ipsnews.net/2010/06/ecuador-chinese-mega-loan-for-dam-draws-fire/.

Pearse-Smith, Scott W.D. 2014. “The Return of Large Dams to the Development Agenda A Post-Development Critique.” *Consilience* 11: 123–31.

Phillips, T. (2010, April 17). Avatar director James Cameron joins Amazon tribe’s fight to halt giant dam. *The Guardian*. Retrieved from https://www.theguardian.com/world/2010/apr/18/avatar-james-cameron-brazil-dam

Poindexter, Gregory B. (2016). *Low water levels at 2,075-MW Cahora Bassa hydropower project in Mozambique reduce generation*. HydroWorld.com. Retrieved from https://www.hydroworld.com/articles/2016/12/low-water-levels-at-2-075-mw-cahora-bassa-hydropower-project-in-mozambique-reduce-generation.html

Population Growth (Annual %). (2016). Retrieved from https://data.worldbank.org/indicator/SP.POP.GROW

Rudo Sanyanga. (2014). *Flooding out a Natural Wonder*. International Rivers. Retrieved from https://www.internationalrivers.org/resources/batoka-gorge-dam-zambezi-river-8291

SADC. (2000). *Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC)*. Retrieved from https://www.internationalwaterlaw.org/documents/regionaldocs/Revised-SADC-SharedWatercourse-Protocol-2000.pdf

Salma Elwardany. (2018, March 13). Desert Sun to Power Upper Egypt With $2.8 Billion Solar Park. *Bloomberg Markets*. Retrieved from https://www.bloomberg.com/news/articles/2018-03-13/desert-sun-to-power-upper-egypt-with-2-8-billion-solar-park

Simon A. Mason. (2004). From Conflict to Cooperation in the Nile Basin. *Swiss Federal Institute of Technology Zurich*.

Snidvongs, A., & Teng, S.-K. (2006). *Global International Waters Assessment: Regional Assessment 55 Mekong River* (Regional Assessment No. 55). United Nations Environment Programme. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/8761/GIWA_regional_assessment_55_Meekong_river.pdf?sequence=3&isAllowed=y

St. James, C. (2016). Why Ecuador doesn't have a renewable energy sector. Retrieved from http://carlosstjames.com/renewable-energy/why-ecuador-doesnt-have-a-renewable-energy-sector/

State Grid to buy remaining stake in Brazil's CPFL. (2017, January 9). *China Daily*. Retrieved from http://www.chinadaily.com.cn/business/2017-09/01/content_31409824.htm

Stickler, C. M., Soares-Filho, B. S., Coe, M. T., Costa, M. H., Nepstad, D. C., McGrath, D. G., … Rodrigues, H. O. (2013). Dependence of hydropower energy generation on forests in the Amazon Basin at local and regional scales. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(23), 9601–9606.

United Nations Framework Convention on Climate Change. (2015). *FEDERATIVE REPUBLIC OF BRAZIL INTENDED NATIONALLY DETERMINED CONTRIBUTION TOWARDS ACHIEVING THE OBJECTIVE OF THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE* (Intended Nationally Determined Contribution).

Vajeth, O. (2016). *Introduction to SAPP*(Presentation). Southern African Power Pool. Retrieved from http://www.energynet.co.uk/webfm_send/1615

Watts, J. (2016, January 15). Belo Monte dam operations delayed by Brazil court ruling on indigenous people. *The Guardian*. Retrieved from https://www.theguardian.com/world/2016/jan/15/brazil-belos-monte-dam-delay-court-indigenous-people

Watts, J. (2017, June 1). Operation Car Wash: Is this the biggest corruption scandal in history? *The Guardian*. Retrieved from https://www.theguardian.com/world/2017/jun/01/brazil-operation-car-wash-is-this-the-biggest-corruption-scandal-in-history

Watts, J. (2018, January 4). Brazil raises hopes of a retreat from new mega-dam construction. *The Guardian*. Retrieved from https://www.theguardian.com/environment/2018/jan/04/brazil-raises-hopes-of-a-retreat-from-new-mega-dam-construction

WB Support Grows for Brazil's Environment. (2009, March 25). Retrieved from http://go.worldbank.org/YT0WTPF2E0

Weatherby, C., & Eyler, B. (2017). *Mekong Power Shift: Emerging Trends in the GMS Power Sector* (Letters from the Mekong). The Stimson Center. Retrieved from https://www.stimson.org/sites/default/files/file-attachments/SC_EnergyPublication.FINAL_.pdf

Yacob Arsano. (2007). Ethiopia and the Nile Dilemmas of National and Regional Hydropolitics. *Swiss Federal Institute of Technology Zurich*.

Zambia Development Agency. (2014). *Energy Sector Profile*. Retrieved from www.zda.org.zm/?q=download/file/fid/55

ZETDC. (2018, May 10). Power Generation Statistics. Retrieved from http://zetdc.co.zw/